THE NESTING HABITS OF EMPHOR BOMBIFORMIS CRESSON.

By Phil Rau, Kirkwood, Mo.

The striking similarity between the nesting habits of certain bees and those of certain wasps often arrests the attention of the observer. Seldom, however, is the resemblance more perfect than in the case of the mining bee, *Emphor bombiformis,* and the two species of Odynerus wasps, *O. dorsalis* and *O. geminus.* All three of these species carry water to moisten the hard earth and thus facilitate their mining and plastering activities; likewise they all strew the pellets of mud around their nests. Some of them practice the quaint and conspicuous habit of building a chimney over the opening and later moistening the chimney and using the mud thus formed for sealing the burrow. Any effort to explain just how such a precise parallelism could have developed in separate groups so distantly related and occurring in different places leads one into fascinating flights of speculation.

When one morning I saw an open burrow surrounded by a ring of clay pellets which distinctly showed the mandible marks, I was certain that it was the nest of *O. dorsalis.* I was fully surprised at finding a bee at the bottom, and so sure was I that this nest belonged to the wasp that I concluded that the bee had crept into the hole merely in quest of a night's shelter. Later evidence showed that this was the normal nest of *E. bombiformis.*

The bees live in more or less scattered colonies, in which each mother makes and maintains her own nest. Colonies of these bees were discovered in 1922 in four distinct localities near St. Louis; they were nesting at North Newstead Avenue, St. Louis, at Fish Lake, Illinois, Creve Coeur Lake, Missouri, and the southwest part of St. Louis. They were seen in the height of their activity between August 8 and September 20.

While all of the nests of this species had the same exterior appearance (Fig 1), with their chimneys and the scattered pellets, as do likewise have the completed nests with their saucer-like depressions in the mud plugs, the inside of the nests of these different groups presented some differences in shape and size.

The channel between the sealing plug and the brood cell is treated differently from those of either of the two wasps mentioned. In the nests of *O. dorsalis,* this channel is clear and free,

Fig. 1.—The resting site of *Emphor bombiformis*.

a sort of air chamber; in *O. geminus,* it is solidly packed with wet mud. In the nest of this bee, we find this space filled in loosely with bits of dry dirt. I had the good fortune to observe closely one mother filling the burrow and closing the top. At 11 a. m. she came home and entered the chimney head first but soon came out backwards, stopped for an instant inside the chimney, turned about and backed down into her hole until her head was level with the surface of the earth, and at a point where the chimney was attached; then after wetting it she began vigorously gnawing away the mud and carrying it down below, thereby demolishing a good portion of the chimney. With seven of these mud balls (for which she fetched water once), she completed the partition over the top cell. With this finished, she changed her technique, and with her forelegs, began to kick the loose soil near the nest into the hollow channel until the hole was full to the top. At this point she once more resorted to the use of water to mix her mortar. Moistening the earth surrounding the opening, she bit out large chunks and sealed the mouth of the burrow, using her abdomen as a trowel. In this way she made a solid plug (fig. 2) as large as a dime and smoothed down to precise saucer shape, and depressed just a little below the surface of the earth.

The turrets are low, (fig. 5) never more than one-half inch above the surface of the soil. They are made of the first mouthfuls of mud taken from the burrow. The products of further excavation are not carried out, but are kicked out in a very pretty fashion. The bee backs up to the top of the turret, and just as her hind legs reach the top, kicks out the pellet with a flip and quick as a flash the mother is down in the hole again, biting out another ball. These pellets are often shot out with such force that they travel horizontally for a distance of from three to five inches. Thus the little bee appears a quaint living shot-gun, as one after another the pellets are catapulted from the burrow. By watching closely, one may see the tip of the abdomen as the bee slowly creeps upward until it is flush with the surface; then as if ejected by a trigger the pellet is suddenly shot out, and while one's eye momentarily follows the pellet the bee quickly slides down and is out of sight. When there is no turret over the nest (nests without turrets are often seen), the pellets ejected often accumulate close to the door-way, as seen in figure 3. She then clears these away in a very practical manner, and by this method she forms the "fairy ring" of pellets as seen in center of figure 1. She

proceeds by holding onto the inside rim of her burrow with her forelegs, and while she stands horizontally on her middle legs on top of the ground, she rapidly runs (while her front legs still cling to the orifice) around and around in "merry-go-round" fashion, rapidly sweeping the pellets away with the hind legs as she makes the circles. Since the strength of her kick is fairly uniform, the pellets are thrown to about the same distance; this results in the pretty fairy ring of pellets already referred to.

The mothers leave their work at intervals to fill their gullets with water. In this case their supply could not have been far away, because each trip required only from two and one-half to three and one-half minutes. The amount of water required varies according to the nature of the soil; in some places the bees could make six or seven loads of mud from one gulletful of water, and in other dry situations, only three or four.

The St. Louis bees made distinct brood cups which could be separated from the nest; those in the gumbo at Fish Lake, and those in the sandy soil at Creve Coeur Lake did not make independent cups, but merely widened the lower portion of the tunnel into a cup-shaped cell, which probably served all practical purposes. The lining wall was wonderfully smooth and glossy, as though finished with some water resisting varnish. But this cell was only the well finished burrow, and not a separate cup within the burrow. Those in the yellow clay were separate and distinct from the tunnel, and were built in true pottery fashion. This difference in the method of nesting of bees of the same species in two localities (and they were actually the same species, because specimens of both groups were submitted to Mr. S. A. Rohwer for identification), is probably due to the two kinds of soil in which they must dig. While this small detail is likely to be taken lightly as a matter of course, yet it is significant in that it shows that the bees actually can or do modify their behavior in accordance with environmental conditions.

When a bee emerges from her burrow to go for water, her manner of exit, either tail first or head first, depends upon whether she is only excavating the gallery or has nearly finished the cell; when the cell is far advanced, she has room enough to turn around and emerges head first; otherwise she must back out.

A few nests that were opened showed the following details of structure and dimensions: One nest had a total length of five inches, which comprised the cell at the bottom, the mud plug at

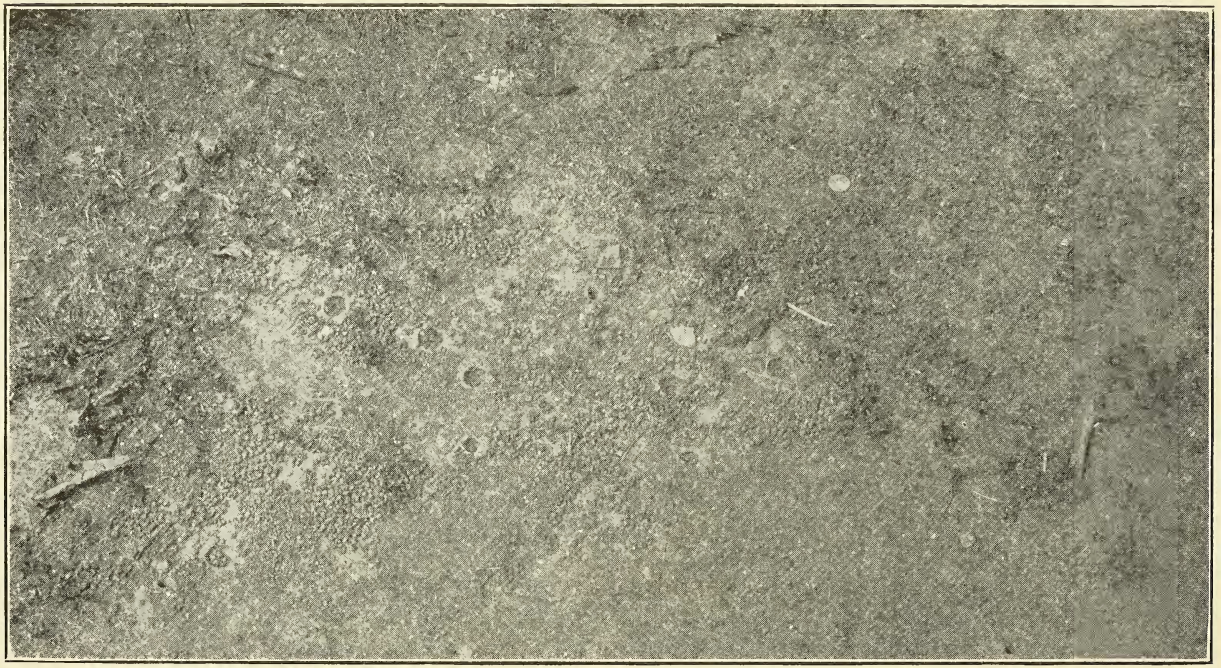

Fig. 2.—The nesting site of *Emphor bombiformis* at the end of the season; thousands of mud pellets are strewn about and wherever a chimney once stood there is now a depression.

the top of this cell, and a filling of loose dirt up to the surface plug of mud. One nest was sealed with a top plug ¼ inch thick; a 1¼ inch tunnel below this was filled with dry bits of earth, and below this were two mud plugs at intervals of ¼ and ¼ inch; these made two additional chambers and, like the first, contained loose bits of earth. Below this was the brood chamber, ¾ inch in depth. The total length of the nest was only 2¾ inches. I have no explanation to offer for the extra partitions. In one nest the mother was discovered at the bottom of the gallery 1½ inches deep; below this was a mud plug and the brood cell, filled with bee bread. Whether or not she was at work building a second cell in the gallery I do not know.

Another nest had a total depth of 3 inches; at the bottom were two cells, one above the other and marked off by mud plugs, and above these was a widening of the gallery which gave the appearance of a cell ¾ inch deep, but this contained no separate brood-cup, as did the others, but was sealed up empty with a heavy surface plug. Four other nests in a group were dug up at Fish Lake. All were about ⅜ inch in diameter, and about 2½ inches in total depth. The brood chamber at the bottom of each measured ¾ by ½ inch, and was packed full of pollen, either yellowish-green or rose-colored. These variations probably were due to the differences in soil. The St. Louis colony worked in yellow clay, the Fish Lake colony mined in a heavy gumbo soil and the Creve Coeur Lake bees nested in hard-packed sandy earth near the lake.

The greater portion of the study was devoted to the Newstead Ave. group. This colony was on a hilltop in a vacant lot, and really comprised two groups ten feet apart. Each half covered an area about three by four feet, and contained a few open burrows in the ground, with chimneys on top, a dozen holes without chimneys and about eighteen closed burrows, easily distinguishable by their saucer-like depressions (see fig. 1), and all over the place the pellets were strewn about. The pellets are always interesting because the mandible marks on each furnish a clear record of the very definite manner in which the balls of moistened earth have been manipulated by the jaws.

Not all of the pellets are scattered about, but those which are brought out first, while they are still wet and plastic, are used in making the chimney. This area of yellow clay was covered with a top layer of dark soil. Often the nests were very conspicuous

by virtue of a scattering of bright yellow pellets (dug from the subsoil) on the dark gray surface.

In the heavy gumbo soil at Fish Lake, each nest was found to contain only one cell. In the clay region in St. Louis, the nests had from one to three cells each. We know that many digging bees and wasps mine a shaft and use the bottom of the tunnel for a nest; but this bee is truly a mason, as well as a digger. The plugs on top are solid pieces of mud masonry; the partitions when she has more than one cell are walls of made mud (fig. 4), and the brood cups when present are distinct and separately fashioned, and show the work of a fully qualified mason. Imbedded in the bottom of these masses of bee bread was the egg, as though it had been deposited first and the food packed on top of it. The eggs were white, and about ¼ by 1/32 inch in size.

Grossbeck[1] has made notes on this species found in New Jersey. He found them nesting in colonies near a cattail marsh, and says they seem to prefer hard, shaly soil in which to nest. He also saw the bees forcibly kick the pellets over the brim of the turrets, sometimes as far as four inches. The New Jersey *E. bombiformis* probably make but one cell to the nest, for while Grossbeck mentions nothing about the number of cells, his figures show but one.

Some observations on the nesting habits of a species closely akin to *E. bombiformis* were published by M. Louise Nichols.[2] This bee, *E. fuscojubatus,* was discovered nesting in a mixture of sand, clay and pebbles; it builds turrets, carries water, jerks out the pellets with considerable force, tears down the turret and uses the material for filling in and closing the nest, and finishes the nest with a circular depression to mark the site. Thus the nesting habits of this species observed at Cape May, New Jersey, differ in no wise from what has been recorded for *E. bombiformis* by either Grossbeck or myself, and since *fuscojubatus* is so nearly related to *bombiformis* that the distinguishing feature is only one of color of pubescence and size of third submarginal cell,[3] it does seem that the bee is changing its taxonomy before or without changing its habits.

[1] Journ. N. Y. Ent. Soc. 19: 283–244. 1911.
[2] Psyche, 1913, p. 107–112.
[3] Cockerell, Psyche, 1913, p. 107.